AD-A102 947 AIR FORCE GEOPHYSICS LAB HANSCOM AFB MA F/G 16/1
SEISMIC HAZARDS STUDIES FOR MINUTEMAN MISSILE WINGS. ADDENDUM. --ETC(U)
MAR 81 J C BATTIS
UNCLASSIFIED AFGL-TR-80-0293-ADD NL

END
DATE FILMED
9-81
DTIC

AFGL-TR-80-0293 (Addendum)
AIR FORCE SURVEYS IN GEOPHYSICS, NO. 431

Seismic Hazards Studies for Minuteman Missile Wings Re-evaluation of the Seismic Hazard for Whiteman AFB, Missouri

JAMES C. BATTIS

27 March 1981

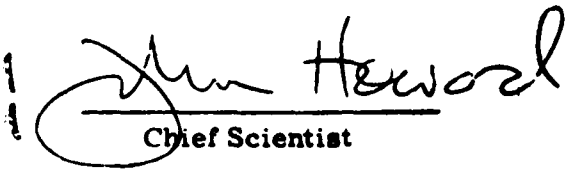
TERRESTRIAL SCIENCES DIVISION PROJECT 7600
AIR FORCE GEOPHYSICS LABORATORY
HANSCOM AFB, MASSACHUSETTS 01731

AIR FORCE SYSTEMS COMMAND, USAF

This report has been reviewed by the ESD Information Office (OI) and is releasable to the National Technical Information Service (NTIS).

This technical report has been reviewed and
is approved for publication.

FOR THE COMMANDER



Chief Scientist

Qualified requestors may obtain additional copies from the
Defense Technical Information Center. All others should apply to the
National Technical Information Service.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: AFGL-TR-80-0293 (Addendum)	2. GOVT ACCESSION NO. AD-A102947 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): SEISMIC HAZARDS STUDIES FOR MINUTEMAN MISSILE WINGS. Re-evaluation of the Seismic Hazard for Whiteman AFB, Missouri.	5. TYPE OF REPORT & PERIOD COVERED: Scientific Final
	6. PERFORMING ORG. REPORT NUMBER: AFSG No. 431
7. AUTHOR(s): James C. Battis	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Air Force Geophysics Laboratory (LWH) Hanscom AFB Massachusetts 01731	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62101F 76000902
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Geophysics Laboratory (LWH) Hanscom AFB Massachusetts 01731	12. REPORT DATE: 27 March 1981 / 13. NUMBER OF PAGES: 11
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified / 15a. DECLASSIFICATION DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report): Approved for public release; distribution unlimited.	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)	
18. SUPPLEMENTARY NOTES	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number): Seismic risk; Seismic motion; Earthquake effects; Ground motion attenuation	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number): Several changes in the technique used to estimate peak ground acceleration attenuation for the central United States significantly altered the acceleration attenuation function used in the seismic risk estimation for Whiteman AFB, Missouri. A re-evaluation of the seismic risk for Whiteman AFB was conducted using the improved attenuation function. The resulting risk curves and design response spectra for Whiteman AFB are presented.	

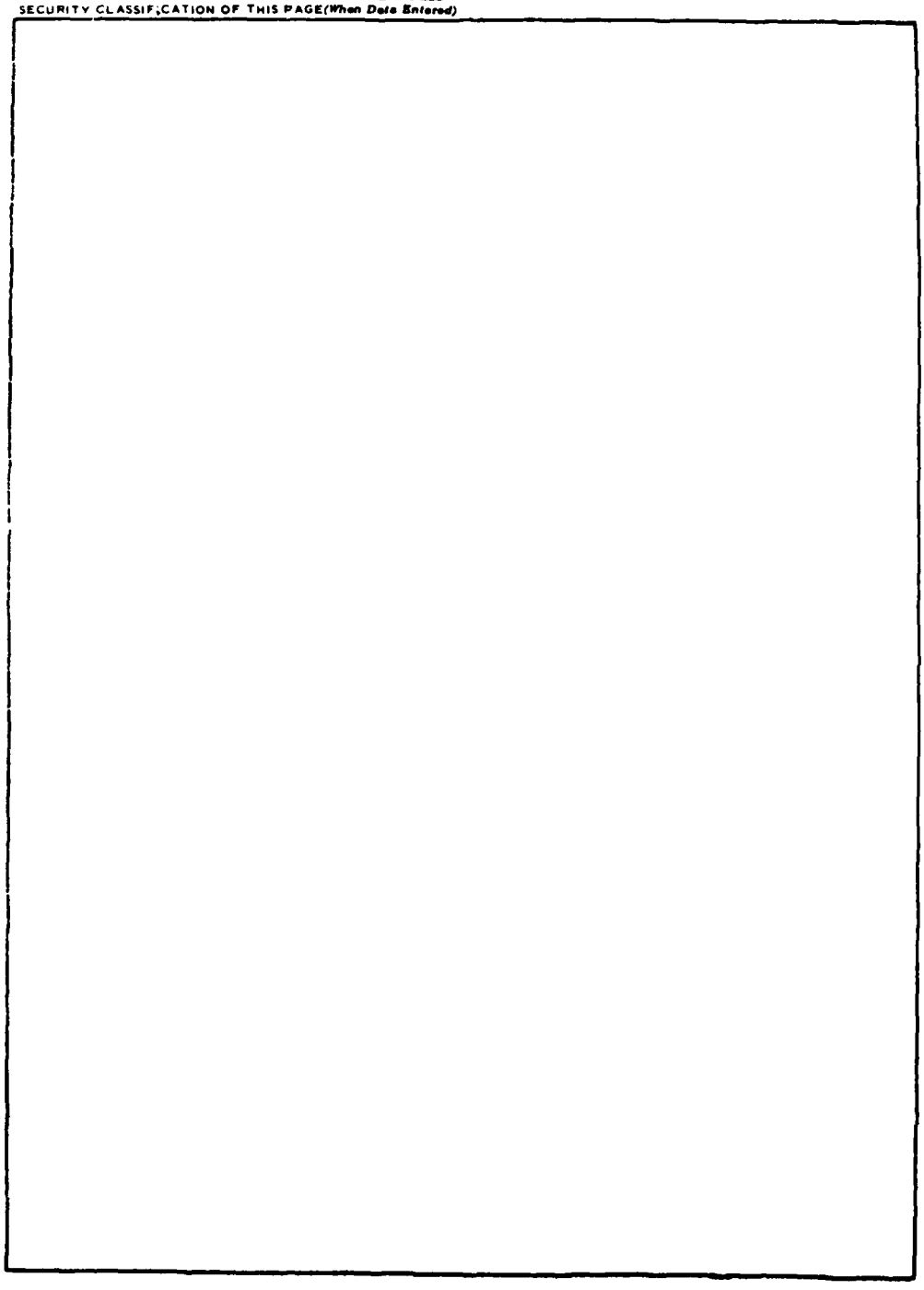
DTIC AUG 17 1981

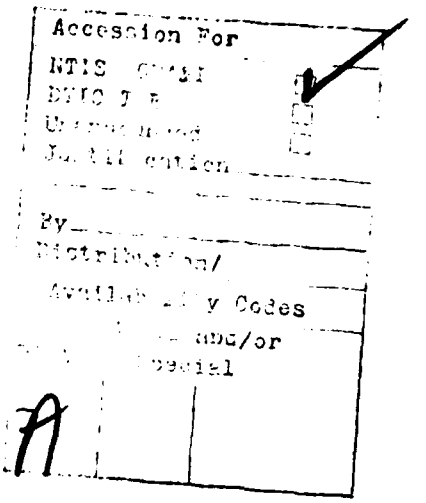
DD FORM 1 JAN 73 1473

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

4015 1





Contents

1.	INTRODUCTION	5
2.	SEISMIC HAZARD FOR WHITEMAN AFB — WING IV	6
3.	CONCLUSIONS	7

Illustrations

1.	Seismic Risk for Whiteman AFB in Terms of Modified Mercalli Intensity	9
2.	Seismic Risk for Whiteman AFB in Terms of Peak Ground Motions	9
3.	Horizontal Design Response Spectra for Whiteman AFB Based on 10-year Return Period Ground Motions	10
4.	Horizontal Design Response Spectra for Whiteman AFB Based on 100-year Return Period Peak Ground Motion	10
5.	Horizontal Design Response Spectra for Whiteman AFB Based on 1000-year Return Period Peak Ground Motions	11
6.	Horizontal Design Response Spectra for Whiteman AFB Based on Peak Ground Motions From an 8.0-m_b Earthquake Occurring at the Approximate Epicenter of the 1811-1812 New Madrid Earthquakes	11

Tables

1. Whiteman AFB Source Region Parameters 7
2. Peak Ground Motion Annual Risk Levels for Whiteman AFB (High Estimate) 8
3. Peak Ground Motion Annual Risk Levels for Whiteman AFB (Low Estimate) 8

Seismic Hazards Studies for Minuteman Missile Wings

Re-evaluation of the Seismic Hazard for Whiteman AFB, Missouri

1. INTRODUCTION

In Appendix A of the report Seismic Hazard Studies for Minuteman Missile Wings, a method was proposed for the development of regionally-modified peak ground acceleration attenuation functions. Since the publication of that report, several significant improvements were made to the method.[1] Among the important changes is the use of body-wave magnitude, m_b, as the magnitude scale by which inter-regional comparisons are made, and a change in the basic equations used to relate epicentral intensity and m_b in California. These changes resulted in modification of the Central United States acceleration attenuation function from that given in Table 2 of the original report; specifically

$$\ln a_s = 4.21 + 1.40\,M - 1.57\,\ln(R + 25) \qquad (1)$$

to

$$\ln a_s = 3.16 + 1.24\,m_b - 1.24\,\ln(R + 25)\,. \qquad (2)$$

(Received for publication 25 March 1981)

1. Battis, J.C. (1981) Regional modification of acceleration attenuation functions, Bull. Seismol. Soc. Am. (in press).

At the same time, an error was found in the conversion of the recurrence curves for the source areas as stated in Table 12 of the original report. A re-evaluation of the seismic risk for Whiteman AFB was conducted and the results are discussed in the following section.

2. SEISMIC HAZARD FOR WHITEMAN AFB – WING IV

The recurrence curve parameters used in this addendum are given in Table 1. In the original report these parameters were given in terms of local magnitude, M_L. Revision of the method by which the acceleration attenuation function is derived now requires the parameters to be based on body-wave magnitude, m_b. The Central Mississippi Valley and background curves were directly derived for m_b.[2] The recurrence function for the Southeastern United States was originally based on Modified Mercalli intensity and converted to m_b by use of the relationship

$$m_b = 1.032 + 0.559\, I_o \,. \tag{3}$$

The Southeastern United States recurrence curve was derived by Bollinger[3] and the equation for conversion from I_o to m_b was evaluated by Brazee.[4]

Using the same methods discussed in the original report, the seismic risk for Whiteman AFB was re-calculated for both site intensity and acceleration. An intensity attenuation function developed by Howell and Schultz[5] was modified using Eq. (3) for use with body wave magnitude data and is given by

$$I_s = -2.01 + 2.73\, m_b - 1.36 \ln R \tag{4}$$

where I_s is site intensity, m_b is the event magnitude and R is the epicentral distance. A standard deviation of 0.66 was used with this function. To evaluate the seismic risk in terms of acceleration, the attenuation function derived by Battis[1] and given in Eq. (2) was used. A standard deviation of 0.707 for $\ln a_s$ was assumed.

2. Battis, J.C., and Hill, K.J. (1977) Analysis of Seismicity and Tectonics of the Central and Western United States, Texas Instruments, Inc., Interim Scientific Report ALEX(02)-ISR-77-01.

3. Bollinger, G.A. (1973) Seismicity of the southeastern United States, Bull. Seismol. Soc. Am. 63:1785-1808.

4. Brazee, R. (1976) An Analysis of Earthquake Intensities With Respect to Attenuation, Magnitude, and Rate of Recurrence, National Geophysical and Solar-Terrestrial Center, NOAA Technical Memorandum EDS NGSDC-2.

5. Howell, B.F., and Schultz, T.R. (1975) Attenuation of Modified Mercalli intensity with distance from the epicenter, Bull. Seismol. Soc. Am. 65:651-655.

For the Central Mississippi Valley source region, risk estimates were first made assuming the maximum magnitude earthquake could occur anywhere within the source region and then only in a restricted region about the apparent epicenters of the 1811-1812 earthquakes. Velocity and displacement risk curves were generated using the "standard" earthquake ratios of 0.5g:60.76 cm/sec:45.72 cm. The revised risk curves are plotted in Figures 1 and 2 for intensity and peak ground motions, respectively. For specified values of risk, the ground motion levels are given in Table 2 for the first case, or high risk estimate, and Table 3 for the second case. Design response spectra based on the high-risk case 10-, 100-, and 1000-year return period ground motions are displayed in Figures 3, 4, and 5, respectively.

Using the revised acceleration attenuation function, the maximum magnitude earthquake, 8.0 m_b, recurring at the approximate epicenter of the 1811-1812 earthquakes would produce significantly smaller ground motions for Whiteman AFB than previously estimated. The new estimates of the resulting ground motions at Wing IV are 293 cm/sec^2, 37 cm/sec and 27 cm. The values are based on an approximate epicentral distance of 355 km and the ground motion ratios of the "standard" earthquake. The horizontal design response spectra for this event at Whiteman AFB is shown in Figure 6.

3. CONCLUSIONS

The modifications to the analysis results in a decrease of approximately one-half of an intensity unit at each level of risk. More significantly, the expected level of acceleration at the lower risks (longer return period) are greatly reduced. This appears to be largely the effect of the re-evaluation of the regional acceleration attenuation function. It is still apparent, however, that for long interoccurrence periods, Whiteman AFB has higher expected ground motions than the other Minuteman Wings due to the lower regional attenuation and greater potential for a major earthquake near the facility.

Table 1. Whiteman AFB Source Region Parameters

Source	Area (10^4 km)	$\text{Log}(N/Y) = A - b m_b$		m_b^{max}
		A	b	
Central Mississippi Valley	15.9	3.047	0.827	8.0
Southeastern United States	43.2	4.099	1.055	7.5
Background*	—	0.380	0.753	6.0

*per 10^4 km^2

Table 2. Peak Ground Motion Annual Risk Levels for Whiteman AFB (High Estimate)

Annual Risk	Return Period (years)	Intensity	Acceleration (cm/sec^2)	Velocity (cm/sec)	Displacement (cm)
0.9	1.11	—	2.0	0.3	0.2
0.5	2	II	4.4	0.6	0.4
0.2	5	III	9.2	1.1	0.9
0.1	10	IV	14.6	1.8	1.4
0.05	20	V	22.7	2.8	2.1
0.02	50	VI	39.7	5.0	3.7
0.01	100	VII	59.9	7.5	5.6
0.005	200	VIII	89.6	11.2	8.4
0.002	500	IX	146.1	18.2	13.7
0.001	1000	IX - X	208.7	26.0	19.5

Table 3. Peak Ground Motion Annual Risk Levels for Whiteman AFB (Low Estimates)

Annual Risk	Return Periods (years)	Intensity	Acceleration (cm/sec^2)	Velocity (cm/sec)	Displacement (cm)
0.9	1.11	—	2.1	0.3	0.2
0.5	2	II	4.5	0.6	0.4
0.2	5	III	9.3	1.2	0.9
0.1	10	IV	14.6	1.8	1.4
0.05	20	V	22.1	2.8	2.1
0.02	50	VI	36.9	4.6	3.4
0.01	100	VI - VII	52.6	6.6	4.9
0.005	200	VII	73.3	9.1	6.9
0.002	500	VIII	109.7	13.7	10.3
0.001	1000	VIII	142.3	17.7	13.3

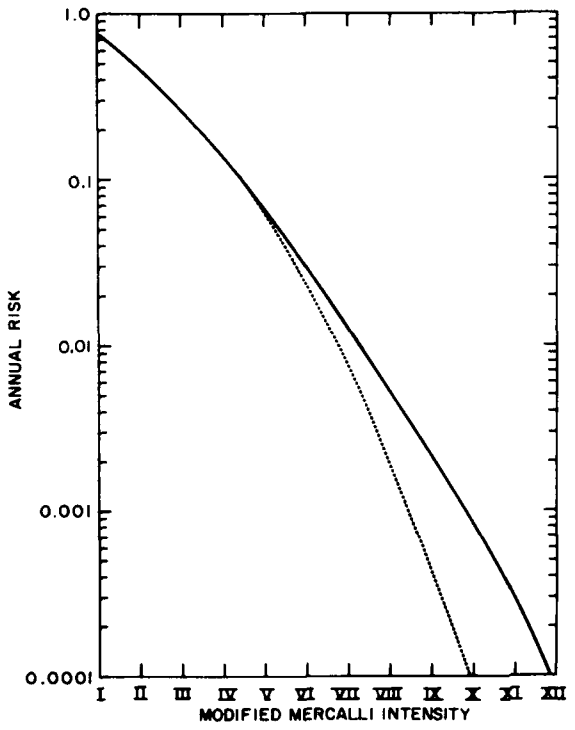


Figure 1. Seismic Risk for Whiteman AFB in Terms of Modified Mercalli Intensity. Maximum magnitude earthquake allowed anywhere in the Central Mississippi Valley source region (solid curve) and restricted location (dashed curve)

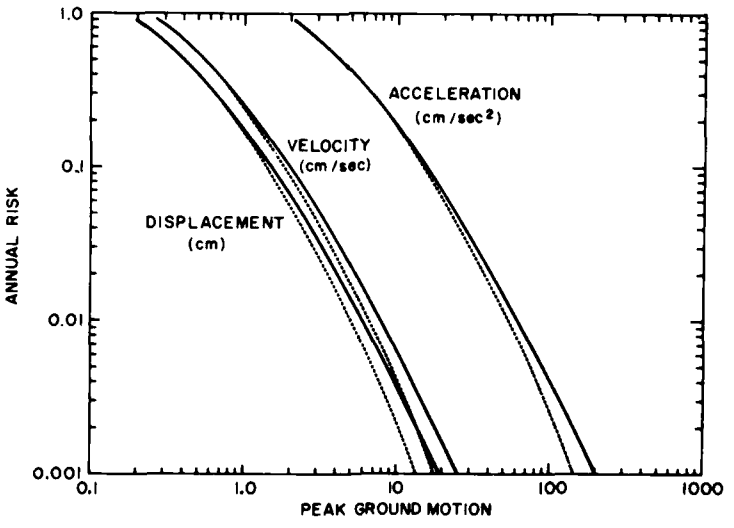


Figure 2. Seismic Risk for Whiteman AFB in Terms of Peak Ground Motions. Maximum magnitude earthquake allowed anywhere in the Central Mississippi Valley source region (solid curves) and restricted location (dashed curves)

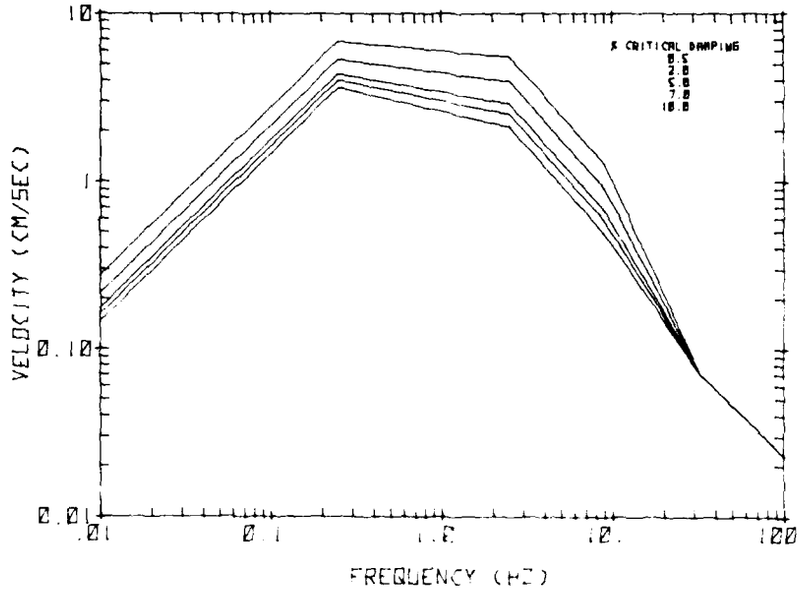


Figure 3. Horizontal Design Response Spectra for Whiteman AFB Based on 10-year Return Period Ground Motions

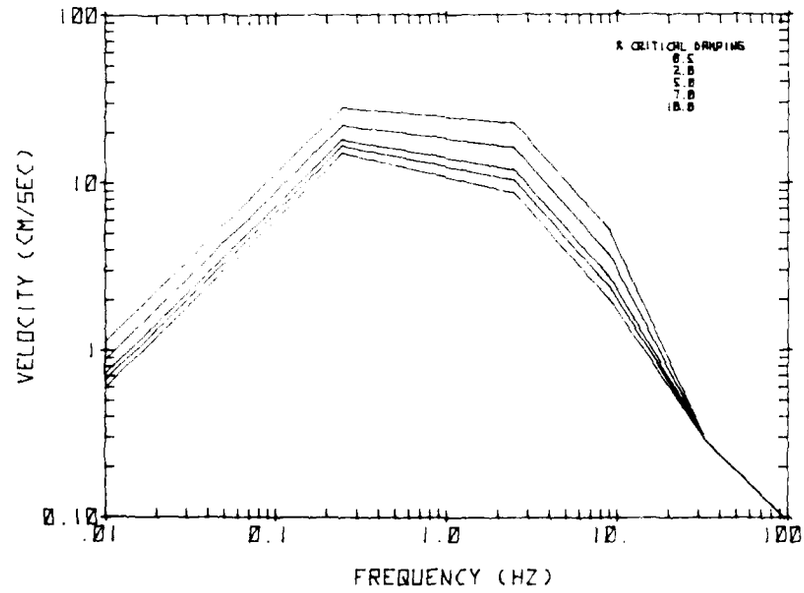


Figure 4. Horizontal Design Response Spectra for Whiteman AFB Based on 100-year Return Period Peak Ground Motions

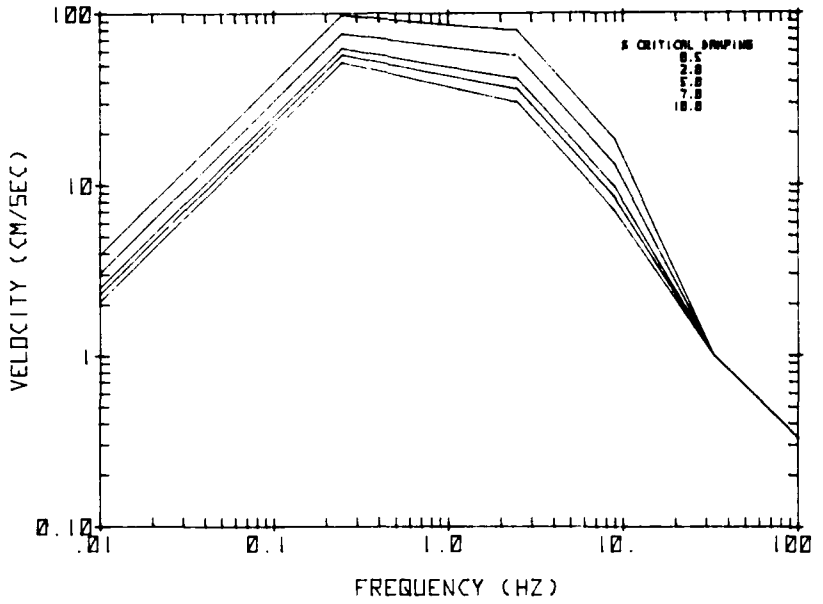


Figure 5. Horizontal Design Response Spectra for Whiteman AFB Based on 1000-year Return Period Peak Ground Motions

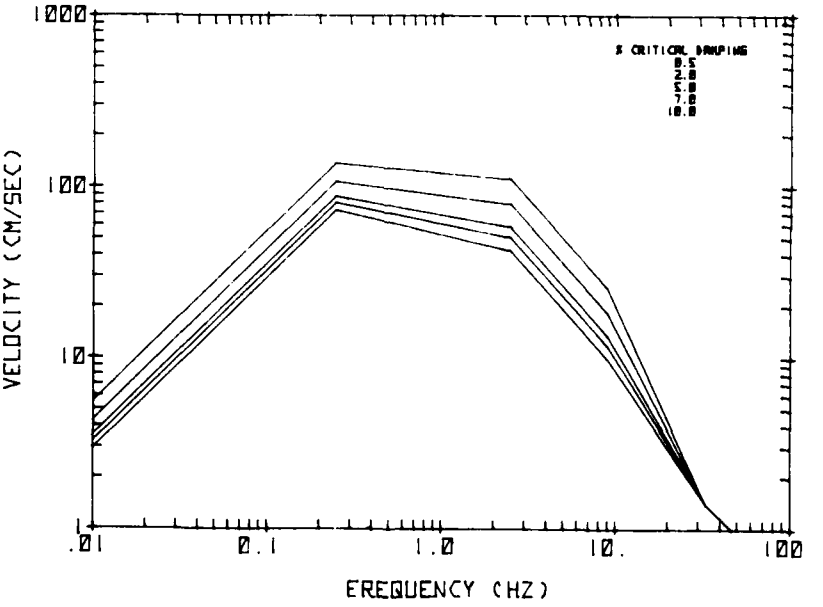
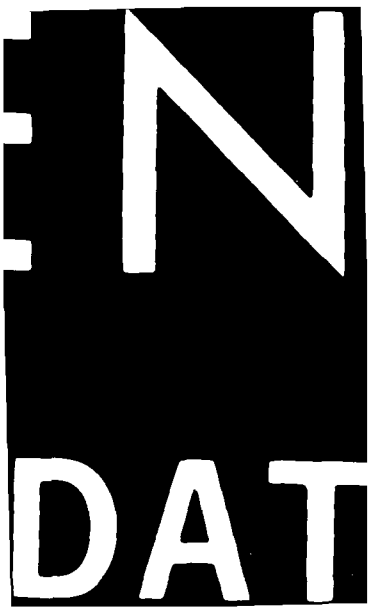


Figure 6. Horizontal Design Response Spectra for Whiteman AFB Based on Peak Ground Motions From an 8.0 m_b Earthquake Occurring at the Approximate Epicenter of the 1811-1812 New Madrid Earthquakes


N
DAT